DOCUMENT RESUME

ED 465 149 CG 031 788

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TITLE	Development of Emergent Math and Literacy Skills.
PUB DATE	2001-08-00
NOTE	11p.; Paper presented at the Annual Meeting of the American Psychological Association (109th, San Francisco, CA, August 24-28, 2001).
PUB TYPE	Reports - Research (143) -- Speeches/Meeting Papers (150)
EDRS PRICE	MF01/PC01 Plus Postage.
DESCRIPTORS	*Emergent Literacy; *Environmental Influences; *Learning Processes; *Mathematics Skills; Predictor Variables; *Preschool Education; Skill Development

ABSTRACT

The purpose of the present study was to determine whether individual differences in children's learning of emergent mathematics and literacy skills existed, and, if they did exist, whether they could be predicted from different child/environment characteristics. Eighty-one three- to five-year-old children took pretests, received training at four different times during the academic year, and four posttests (one after each training) in this longitudinal study. Researchers were able to identify three different types of learning curves for the emergent literacy (i.e., blending, letter-identification) and math skills (i.e., counting and number identification) in the sample: no change, slow, and rapid change. Prior level of experience and general intelligence (but not age) were two reliable predictors of children's individual growth curves. (Contains 10 references.) (Author)

Development of Emergent Math and Literacy Skills

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During preschool years, children develop skills that are developmental precursors to reading, writing, and development of number sense (Whitehurst & Lonigan, 1998). For example, knowledge of letter names is a good predictor of later reading achievement (Adams, 1990; Treiman, 2000). Whereas much research has been conducted on emergent literacy skills, only few quantitative studies on young children's mathematics skills have been conducted (Gifford, 1995). Researchers point out that young children's understanding of number concepts have been seriously underestimated and that preschoolers are ready to learn mathematics through informal experiences, through handling and counting objects found in their natural environment (Charlesworth & Lind, 1990). Training on counting, for example, has been linked to improvement in number sense -- on such tasks as counting, classification and seriation (Clements, 1984), and addition and subtraction (Baroody, 1987).

Most of the training studies in the area of emergent literacy and mathematics look at the relationship of these emergent skills and later achievement (see Bus & Ijendoorn, 1999 or Leder, 1992 for review). Individual differences in learning about literacy or mathematics are rarely investigated (Treiman et. al., 1998). Simultaneous study of the

development of emergent mathematics and literacy skills has not been previously looked at empirically.

Vygotsky (1978) postulated that two measures of performance, independent performance and performance under instruction, are needed to more fully understand child's ability level. By modeling individual differences in growth curves of children who receive instruction we are better able to test Vygotsky's idea that initial status and learning responsiveness (via growth curve analysis) are necessary to describe child's abilities as well as to identify important characteristics that would successfully predict such growth curves.

The Present Study

This study used hierarchical linear modeling techniques (HLM) to assess individual growth trajectories, a statistical technique that permits researchers to focus on individual differences in change before focusing on the group level parameters. HLM allows one to evaluate variables that predict individual differences in growth curves as well as use growth curves as predictors of later performances.

The specific goals of this study were: (1) to investigate the existence of individual difference in learning about emergent mathematics and literacy, (2) to identify predictors of individual learning curves, and (3) to identify the relationship between children's initial status and rate of growth in each of the two domains.

Method

Participants

One hundred and sixty Head Start children from a midwestern university town participated in the study. Fifty one percent of the children were boys. At the start of this study, participants ranged in age from 3 years 4 months to 5 years 6 months. The mean age for the sample was about 4 years 5 months. Approximately 59% of the children were African-Americans, 18% were Caucasian and 18% were Hispanic.

Design

All children were randomly assigned to one of the four conditions: math and literacy instruction, math only instruction, literacy only instruction or attention control. Children in the math only instructional condition used materials involving numbers whereas children in the literacy only instructional condition utilized materials focusing on the literacy skills (e.g., alphabet identification, rhyming themes, etc.). Children in the combined condition (i.e., math and literacy instructional condition) engaged in both types of instruction mentioned above. Those students in the control condition participated in activities focusing on insects, not literacy or mathematics skills.

Measures

Four types of skills were investigated in this study: blending, letter identification, counting, and number identification. Blending subscale was comprised of 10 items. Blending is a phonological skill that requires the sounds of a word to be combined to pronounce the word correctly (e.g., C-A-T → CAT). An example of a blending question was: "If I say M-AP, you say ____ ?" The internal consistency coefficient was .88 (KR 20).

Letter-Identification subscale (e.g.,"What letter is this (B)? How about this one (F)?, etc.) consisted of 12 items (KR 20 = .93).

Counting subscale was composed of 6 items such as: "I will count and you say the number that comes next: 12, 13, ..." The child was expected to say "14". The internal consistency for the counting subscale was .64 (KR 20).

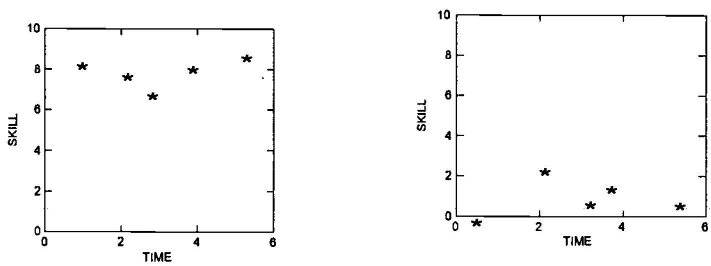
Number Identification subscale consisted of 6 items. A researcher presented a child with a flash card with number 14 on it and asked: "What number is this?" KR 20 for the Number Identification subscale was .83.

Procedure

Before any pretests were given, research assistants participated in different classroom activities to get acquainted with the children. Each child was then individually tested for approximately 20-30 minutes at each test time. The duration of the study was 30 weeks. Children had one pretest and four posttests on the Emergent Mathematics Skills Test (EMST) and the Emergent Literacy Skills Test (ELST), and a pretest on the Woodcock-Johnson Tests of Achievement (tests 22 and 33). The EMST and the ELST were administered five times: (1) at the beginning of the study (week 1-3), (2) after the end of teaching (posttest 1), (3) at the beginning of the spring semester, and (4) (5) at the end of teaching periods two and three. The order of administration of the tests at each time point was random. Children were randomly assigned to one of the four instructional conditions: math and literacy, math only, literacy only instruction or attention control. During three intervention sequences throughout the school year children received instruction in three types of activities (i.e., math or literacy or insects). Nine activities were designed for each type of activity.

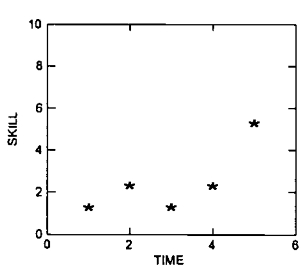
Results

Hierarchical linear modeling calculates both an intercept and a slope parameters for each individual by regressing each type of skill into time. Individual differences in growth (i.e., slope) and initial status (i.e., intercept) are then modeled for the combined condition only (due to space limitations) controlling for age and general intelligence.

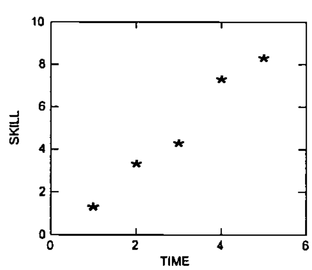


No change

3 types of individual differences in growth trajectories were identified across all types of skills: no change, slow change and rapid change. The fit of the quadratic model was poor (<u>Beta</u>= -.19 to .03 for different subscales, <u>t</u>= -1.4 to .23 , all <u>ps</u>>.05).



Slow change



Rapid change

The learning curves presented here are charted at the individual level.

Children's rates of growth were also analyzed within the most extensive instructional condition (i.e., math and literacy condition) because we wanted to understand what environmental/child characteristics contribute to individual differences

that were observed when children were exposed to a variety of developmentally appropriate activities. Multiple regression analyses were run for each of the skills with age, general intelligence, and children's pretest performance as predictors of individual growth curves. General intelligence was a significant predictor of individual growth curves on both math skills (counting- B=.35, SE=.004, p<.05; number-identification- B=.38, SE=.006, p<.05) but not on literacy skills (blending- B=-.057, SE=.03, p>.05; letter-identification- B=.477, SE=.02, p>.05). Children with higher intelligence were able to learn quicker than children with lower IQ scores. Age was not a significant predictor of rate of growth on all skills (counting- B=.29, SE=.01, p>.05; number-identification- B=.18, SE=.014, p>.05; blending- B=.24, SE=.03, $p\geq$.05; letter-identification- B=.21, SE=.04, p>.05). Prior level of experience significantly predicted individual growth curves on all skills (counting- B=-.83, SE=.042, p<.001; number-identification- B=-.48, SE=.05, p<.05; blending- B=-.89, SE=.06, $p\leq$.001; letter-identification- B=-.601, SE=.098, $p\leq$.05). Overall, in the present analyses we were able to successfully predict individual rates of growth from prior level of experience and general intelligence but not age.

One of the goals of the study was to investigate whether growth in one skill correlates positively with growth in other skills. It is true for all investigated skills that lower initial status is associated with more individual growth (e.g., $r_{\text{blending,intercept \& blending, slope}}$ = -.8). Learning in counting is positively correlated with growth in number-identification skills (e.g., r=.408*). However, growth in blending was not correlated with growth in letter-identification (e.g., r=.045).

Discussion

1. Individual differences in growth rates exist across two domains (i.e., math and literacy) in preschool-aged children.

We were able to identify different learning curves for blending, letter-identification, counting and letter identification skills in our sample: no change, slow, and rapid change. Even though three-five year old children exhibited the same learning patterns across two studied domains, rapid change growth curves were more common in number identification and counting skills. Head Start children had difficulties with blending phonemes of the presented words, therefore, no change or slow change growth rates were observed more often.

2. What factors predict individual rates of growth?

Prior level of experience and intelligence were identified as predictors of individual growth rates. Those children who had less experience and those with higher general intelligence scores learned emergent math and literacy knowledge faster. Age did not predict individual growth curves in our sample. General intelligence scores were significant predictors only in the area of mathematics but not in the area of literacy. Overall, we have demonstrated how individual growth modeling could be successfully used to measure the zone of proximal development and identify predictors of change over time. Accurate assessment of children's potentials is critical if change in learning is being described. Additional predictors of children's performance (such as, for example, motivation or attention) need to be considered to fully understand what child and environment characteristics predict how quickly children learn.

3. How does rate of change correlate with initial status?

Children who had less prior knowledge benefited more from the provided instruction than children who were more skilled and knowledgeable. Learning in one math skill (e.g., in counting) was positively correlated with learning in another emergent math skill (e.g., in number-identification). This was not true for the literacy domain. We suspect that no relationship between emergent skills (i.e., blending and letter-identification) is partly due to children's difficulty in blending tasks.

This study reinforces the importance of developing children's emergent skills. However, because individual differences in learning exist as early as three years of age, important educational implications follow. Both teachers and parents need to be more sensitive to children's learning. Instruction is most beneficial when it matches student's individual needs and characteristics.

References

Adams, M. J. (1990). Beginning to read: Thinking and learning about print. Cambridge, MA: MIT Press.

Baroody. A. J. (1987). The development of counting strategies for single-digit addition. Journal for research in mathematics education, 18(2), 141-157.

Bus, A. G., & van IJendoorn, M. H. (1999). Phonological awareness and early reading: a meta-analysis of experimental training studies. Journal of Educational Psychology, 91(3), 401-414.

Charlesworth, R., & Lind, K. K. (1990). Math and Science for Young Children. Albany, NY: Delmar.

Clements, D. H. (1984). Training effects on the development and generalization of Piagetian logical operations and knowledge of number. Journal of Educational Psychology, 76 (5), 766-776.

Gifford, S. (1995). Number in early childhood. Early Child Development and Care, 109, 95-119.

Leder, G. C. (1992). Mathematics before formal schooling. Educational Studies in Mathematics, 23, 383-396.

Treiman, R. (2000). The foundations of literacy. Current Directions in psychological Science, 9(3), 89-92.

Vygotsky, L. S. (Ed.) (1978). Mind in society: The development of higher psychological processes. Cambridge: Harvard University Press.

Whitehurst, G. J., & Lonigan, C. J. (1998). Child development and emergent literacy. Child Development, 69(3), 848-872.

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